

Department of Parasitology and Parasitic Diseases,
Agricultural College of Wrocław
Head: Prof. Dr. Gustaw Poluszyński

Stanisław PATYK

Helminths in the alimentary tract of cattle in West Poland

Robaki przewodu pokarmowego bydła w Polsce Zachodniej

The present paper constitutes the second phase of my studies on the parasitofauna of the alimentary tract of the domestic ruminants. The first work dealt with the helminths of the alimentary tract in sheep and goats (1956). Post-mortem examinations of the alimentary tract of cattle were continued with few intermissions from 1949 till 1956. During the period ranging from September 1949 till March 1950 Mrs. Stehlik conducted 30 post-mortem examinations of the alimentary tract (rumen, abomasus, small intestine, caecum, large intestine), the remaining 50 dissections (abomasus, caecum, small intestine, caecum and large intestine) were made by myself. And so since the middle of May till October 1954 I conducted 35 post-mortem examinations of the alimentary tract, in August and September of the next year — 9 and in September 1956 — 6.

The total number of the examined alimentary tracts was 80. Besides this in 1955 I conducted post-mortem examinations of 300 oesophaguses of cattle.

The material for studies was collected from normal animals, mainly young individuals, directed to slaughter to the abattoir in Wrocław. As far as I could get orientated from the certificates, the majority of the examined cattle originated from the Wrocław palatinate and only a small number from the palatinates: Zielona Góra, Poznań and Kielce. Accurate determination of the place of origin of the animals offered serious difficulties because frequently the animals had no ear-lobe marks and also because there were great numbers of animals directed to slaughter.

Technic of studies

The dissections of the alimentary tract of cattle were made by using generally simple methods as previously in sheep and goats. The larvae of *Oesophagostomum radiatum* were observed under a trichinoscope by flattening the nodes isolated from the intestine in a compressor. Histopathological preparations were made from some nodes.

In search of nematodes of the genus *Gongylonema* I cut along the oesophagus and separated the mucous membrane. Next the muscular layer together with the connective tissue and the mucous membrane were accurately examined. In dubious cases I examined the mucous membrane by using a binocular magnifying glass.

To isolate spicules and gubernaculum I used Clapham's (1947) method which prescribes the use of 0.75—1% solution of sodium hydroxide.

Results of studies

In the elaboration of the material attention was turned above all on the species set of the parasitofauna, its habitat in the host, and intensity and extensity of invasion. Besides this, during post-mortem parasitological examinations. I turned my attention to the eventual presence of lesions of anatomo-pathological character. I am enclosing also my own observations concerning the morphology of the gubernaculum in some species of nematodes. However, I did not include to the text the description and figures referring to 5 species of nematodes, specific to cattle, but hitherto not recorded in Poland; I refrained also from giving the measurements of the separate species of the nematodes made with few exceptions on 20 individuals (10 males and the same number of females) for every species, because the data on the whole did not differ from data present both in the foreign and in our helminthological literature (Sjöberg, 1926; Skrjabin, 1954; Żarnowski, 1949; Patyk 1956).

In the examined material I found the total number of one species of trematode, two species of tapeworms and 16 species of nematodes. The list of the parasites is presented:

Trematodes:

Paramphistomum cervi

Tapeworms:

- 1) *Moniezia benedeni*
- 2) *Moniezia expansa*

Nematodes:

- | | |
|-----------------------------------|--------------------------------------|
| 1) <i>Ostertagia ostertagi</i> | 9) <i>Nematodirus filicollis</i> |
| 2) <i>Ostertagia lyrata</i> | 10) <i>Bunostomum phlebotomum</i> |
| 3) <i>Trichostrongylus axei</i> | 11) <i>Oesophagostomum radiatum</i> |
| 4) <i>Haemonchus contortus</i> | 12) <i>Oesophagostomum venulosum</i> |
| 5) <i>Cooperia oncophora</i> | 13) <i>Chabertia ovina</i> |
| 6) <i>Cooperia mcmasteri</i> | 14) <i>Capillaria longipes</i> |
| 7) <i>Cooperia punctata</i> | 15) <i>Trichuris discolor</i> |
| 8) <i>Nematodirus helvetianus</i> | 16) <i>Trichuris ovis</i> |

The species *O. lyrata*, *C. punctata*, *B. phlebotomum*, *O. radiatum* and *Trichuris discolor* were hitherto not recorded in our ruminants.

I found also *Strongyloides* sp. (P a t y k, 1958) in the course of the examination of the faeces of cattle which remained on pastures around Wrocław, irrigated by municipal gutters.

TREMATODA

Paramphistomatidae Fischöeder, 1901

Paramphistomum cervi Schrank, 1790

Habitat: rumen.

I found this trematode in three cases (in 30 examined rumens = 10%), in the total number of 267 individuals.

CESTODA

Anoplocephalidae Cholodkovsky, 1902

Moniezia benedeni (Moniez, 1872) Jenkins, 1923

Habitat: small intestine.

The specimens found by me measured 4—135 cm. Usually I found them together with nematodes (3—10 species), and only once they were the sole parasite of the alimentary tract. A total number of 29 individuals were found in 11 (14%) animals. The highest number in one host was 10 individuals.

Moniezia expansa (Rudolphi, 1805) Blanchard, 1891

Habitat: small intestine exclusively.

M. expansa was found in one case as a single specimen together with 9 species of nematodes.

NEMATODA

Trichostrongylidae Leiper, 1912*Ostertagia ostertagi* (Stiles, 1892) Ransom, 1907

Habitat: abomasus, rarely duodenum.

After *Cooperia oncophora* the most common parasite of the examined cattle. I found it in the total number of 32674 parasites in 37 (46%) animals. I found *O. ostertagi* in the abomasus 30 times (1 — 6626 parasites) and 7 times in the abomasus and duodenum (1 — 5113) always jointly with other species. The maximal number in one host was 6626 parasites.

Ostertagia lyrata Sjöberg, 1926

Habitat: abomasus exclusively.

I found *O. lyrata* in mixed invasions in 24 animals (30%) and always with *Ostertagia ostertagi*. I found a total number of 1284 individuals, whereby the highest number in one host was 376.

Trichostrongylus axei (Cobbold, 1879) Railliet
et Henry, 1909

Habitat: abomasus

I found *T. axei* in the total number of 489 specimens in 10 (12.5%) cattle. The highest number of the parasites in one host was 140. This parasite occurred in mixed invasions.

Haemonchus contortus (Rudolphi, 1803) Cobbold, 1898

As the characteristic mark of the majority of females is the presence of small, rounded cuticle-hypodermal processus in the region of the genital pore.

Differences between *Haemonchus* from cattle and *Haemonchus* from sheep. The separateness of the two species was proved in two works, of which one (Roberts, Turner et McKeve, 1954) describes the morphological differences between the sheep and cattle forms of *H. contortus*, and the second (Bremner, 1955) deals with cytological studies of the two forms of parasites. According to Roberts' and his coauthors' data the basic characteristics which differentiate the forms from cattle from forms from sheep are: length of the spicule in males and the distance of the thorns from

their posterior end, shape of the process in the region of the vagina and the total length and the length of the tail of the moulting of the invasive larvae.

Table I

Differences between *Haemonchus* from sheep and cattle (in mm)

Data	Roberts, Turner and Mckeve, 1954	Present author
Male of <i>Haemonchus</i> from sheep		
Length of spicules	0.410 — 0.434	0.392 — 0.449
Distance between thorn of left spicule and its posterior end	0.021 — 0.022	0.019 — 0.025
Distance between thorn of right spicule and its posterior end	0.040 — 0.043	0.040 — 0.047
Male of <i>Haemonchus</i> from cattle:		
Length of spicules	0.460 — 0.474	0.476 — 0.496
Distance between thorn of left spicule and its posterior end	0.026 — 0.028	0.026 — 0.030
Distance between thorn of right spicule and its posterior end	0.052 — 0.054	0.048 — 0.056

As seen from the comparison (Table I) the spicule from the two hosts show distinct difference in the length and in the distance of the thorns from their posterior end. The spicule of the males from cattle have longer dimensions and increased distances of the thorns from the spicule of the parasites of sheep, whereby the distances both according to the observations of Roberts et al. and my observations are independent from the length of the spicule.

A further characteristic which differentiates the majority of females of *Haemonchus* from cattle is according to Roberts et al. the presence of a small, rounded process (93.5% of examined parasites) in the region of the genital pore, while in the majority of the females from sheep it is long and in the shape like a tongue (88.9%). The mentioned authors found in the females collected from natural invasions in cattle and sheep from various districts of Australia the presence of 14 basic types of the process and a certain number of intermediate forms.

For the separateness of the species *Haemonchus* from cattle supports also the total length of the invasive larva and the tail length

of moulting. According to Roberts et al. the total length of the larvae in cattle is 0.775 — 0.807 mm, and the length of the tail of the moulting is 0.165 — 0.173 mm, and the corresponding data for the larvae from sheep are 0.708 — 0.752 mm and 0.134 — 0.145 mm.

Besides the morphological differences Bremner found also genetic differences between the two forms. He conducted studies on the parasites of the two species, originating from natural and mixed invasion and from experimental pure and mixed invasion. The author found that the number of chromosomes for the two species of parasites was $2n = 11 \text{ ♂}$, 12 ♀ , whereby the autosomes of each form measured 0.003 mm in length. The genital chromosomes of *Haemonchus* from sheep were of the same length as autosomes, and the genital chromosomes of parasites from cattle attained the length of 0.008 mm.

The morphological differences found by me referring to the length of the spicules and the distance of the thorns from their posterior end induce me to draw the conclusion that *Haemonchus* from cattle is a separate species with this reservation, however, that I will conduct supplementary studies above all on the invasive larvae and the genetic structure of the two forms of the parasites.

Habitat: *Haemonchus* is first of all a parasite of abomasus rarely duodenum.

I found *H. contortus* in 28 (35%) cattle. The total number of the parasites found by me was 6859, at the maximal number of 2961 individuals in one host. Invasions, mainly mixed, were found 20 times in the abomasus and barely once in the duodenum, and 7 times simultaneously in abomasus and duodenum. In the 4th stomach I found 6820 parasites, in the duodenum 39.

Cooperia oncophora (Railliet, 1898) Ransom, 1907

Habitat: small intestine, rarely abomasus.

This species is the most common; in the examined animals I found it in 42 cases, what constitutes 52%. It occurred above all in the small intestine, rarer, however, simultaneously in the small intestine and abomasus (9 times). The greatest number of parasites in one animal was 2683, and the total number of the individuals found by me was 12 091. The invasions were in the majority mixed, and only 5 times was this species the sole inhabitant of the alimentary tract.

Cooperia mcmasteri Gordon, 1932

Habitat: small intestine.

Averagely frequent parasite, found by me in 29 (36%) of the examined animals. The females of this species, according to data in the literature as well as also in my observations, are very similar to females of *C. oncophora*. I found them always in mixed invasions together with females of *C. oncophora*, what created serious difficulties in the determination. The highest number of males in one host was 46. The total number of them was 443.

Cooperia punctata Linstow, 1907

Habitat: small intestine, rarely abomasus.

I found *C. punctata* in 16 animals (20%) in the total number of 1484 individuals. This species occurred in not great numbers, only once I found 1068 parasites. I found it in the small intestine 10 times, in the abomasus — 2 times and 4 times simultaneously in the small intestine and abomasus, mainly with *C. oncophora* and always in mixed invasions together with other species.

Nematodirus helvetianus May, 1920

Habitat: small intestine, rarely abomasus.

This species was a fairly commonly occurring parasite in the examined animals. I found it 28 times what means in 35% of animals. *N. helvetianus* occurred always in mixed invasions and so in the small intestine 24 times in numbers ranging from 2 — 1443, once in abomasus (1 specimen), and three times simultaneously in abomasus and small intestine (1 — 17 specimens). The maximal number of the parasites found was 1443. I found the total number of 2811 individuals.

Nematodirus filicollis (Rudolphi, 1802) Ransom, 1907

Habitat: small intestine.

This species was found by me in one case; 16 of them occurred in the presence of 8 other species of nematodes.

Ancylostomatidae (Looss, 1905) Lane, 1917
Bunostomum phlebotomum (Rudolphi, 1803) Railliet, 1900

Habitat: small intestine, rarely abomasus.

B. phlebotomum was found in mixed invasions in 14 cases (17%) and principally in the small intestine (11 times), rarely in the abomasus (once) and two times simultaneously in the small intestine and abomasus. The total number of 256 parasites was found. The greatest number present in one host was 126 individuals.

Strongylidae Baird, 1853

Oesophagostomum radiatum (Rudolphi, 1803) Schnyder, 1906

Fig. 1

The gubernaculum according to my observations made by the use of sodium hydroxide is a complex apparatus. It consists of the proper gubernaculum and two lateral plates. The proper gubernaculum has the shape of a shovel, is 0.055 — 0.079 mm (average

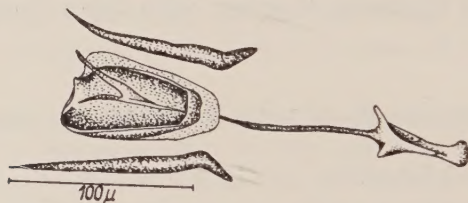


Fig. 1. *Oesophagostomum radiatum* — gubernaculum.

0.068 mm) in length, and is provided on the posterior end with a long, thin process 0.084 — 0.112 mm (average 0.102 mm) in length. In the majority of specimens the terminal part of the process shows the presence of a small plate of the appearance of a handle of a bayonet. The lateral plates are not of an even length and resemble by their appearance the runners of a sledge. The length of the left plate 0.087 — 0.110 mm (average 0.106 mm), that of the right 0.096 — 0.125 mm (average 0.115 mm). The plates are located on the external side of the spicules and they most likely play the role of cramps during the movement of the spicules and the gubernaculum.

Habitat: large intestine and caecum.

This species was after *C. oncophora* and *O. ostertagi* the most common parasite in cattle. The extensity of invasion was 41% (33 cases). In the large intestine I found *O. radiatum* in 9 cases and 2 times in the caecum, and 22 times simultaneously in the two sections of the alimentary tract. The greatest intensity of invasion was 236 individuals. I found the total number of 1156 parasites. The invasions were constantly mixed.

Oesophagostomum venulosum (Rudolphi, 1809)

Railliet, 1885

The morphological structure of the gubernaculum in this species is similar to that in *O. radiatum*.

Habitat: caecum and large intestine.

A rare parasite, found in 4 animals (5%), two times in the caecum (1 and 55), once in the large intestine (26) and once simultaneously in both sections of the alimentary tract. The maximal number of parasites in one host was 55. I found the total number of 113 individuals, whereby the invasions had always a mixed character.

Chabertia ovina (Fabricius, 1788) Railliet

et Henry, 1909

Habitat: large intestine.

A rare parasite in the examined animals, found in mixed invasions in 3 cases (4%). The intensity of invasion 1 — 2 specimens.

Trichuridae Railliet, 1915

Trichuris discolor Linstow, 1906

Habitat: caecum, rarely large intestine.

This worm belongs to medium commonly occurring parasites. I found it 23 times (29%), 12 times in the caecum, 10 times simultaneously in the caecum and large intestine, and only once in the latter part of the alimentary tract. A total number of 162 individuals was found. The invasions were mainly mixed and the maximal number in one host was 33 parasites.

Trichuris ovis (Abildgaard, 1755) Smith, 1908

Habitat: caecum.

T. ovis, similarly to *Chabertia ovina*, belongs to very rare parasites of cattle. I found it in mixed invasions in 3 cases in numbers of 1 — 6 individuals. The total number of 9 parasites was found.

Capillaria longipes Ransom, 1911

Habitat: small intestine exclusively.

C. longipes was found in 5 (6%) animals. The invasions were mixed and their intensity was 1 — 8 individuals. The total number of parasites found was 19.

Discussion of results

The animals examined by me were invaded in 78.7%. The total number of parasites found by me was 60 197, of which 267 were trematodes (not shown in Table II), 30 — tapeworms, and 59 900 nematodes.

The general state of the invasion of the alimentary tract in cattle can be presented (Skrjabin, 1946; Patyk, 1953) by the following helminthocenotic index:

$$\frac{80 \text{ (Trematoda 10, Cestoda 15, Nematoda 75)}}{966 \text{ (396.2 — 78.7) } 19}$$

The index shows that in the 80 examined cattle there were 10% invaded with trematodes, 15% — with tapeworms and 75% — with nematodes. One animal invaded with worms was the host of 966 parasites and 3.96 of the species of the parasite. The percentage of the invaded animals is expressed by the number 78.7 and the invasion with worms was the work of 19 species of parasites.

As shown in the Table II the highest number of parasites was found in abomasus (43 754), less in the small intestine (15 604) and the least — in the large intestine (745) and caecum (697). In accordance with this the number of species present in the small intestine was 12, in abomasus 9, and the lowest number in the caecum and large intestine, 4 species in each.

Table II

Habitat of parasites in alimentary tract, intensity and extensity of invasion

No	Parasite species	Rumen	Small intest.	Caecum	Large intest.	Maximal intensity of invasion	Total no. of parasites	Extensity of invasion
1	<i>Haemonchus contortus</i>	6820	39	—	—	2961	6859	35
2	<i>Ostertagia ostertagi</i>	32622	52	—	—	6626	32674	46
3	<i>Ostertagia lyrata</i>	1284	—	—	—	376	1284	30
4	<i>Cooperia oncophora</i>	328	11763	—	—	2683	12091	52
5	<i>Cooperia mcmasteri</i>	54	389	—	—	46	443	36
6	<i>Cooperia punctata</i>	1231	253	—	—	1068	1484	20
7	<i>Trichostrongylus axei</i>	489	—	—	—	140	489	12
8	<i>Nematodirus helvetianus</i>	21	2790	—	—	1433	2811	35
9	<i>Nematodirus filicollis</i>	—	16	—	—	16	16	1
10	<i>Bunostomum phlebotomum</i>	5	251	—	—	126	256	17
11	<i>Capillaria longipes</i>	—	19	—	—	8	19	6
12	<i>Trichuris discolor</i>	—	—	132	30	33	162	29
13	<i>Trichuris ovis</i>	—	—	9	—	6	9	4
14	<i>Oesophagostomum radiatum</i>	—	2	472	682	236	1156	41
15	<i>Oesophagostomum venulosum</i>	—	—	84	29	55	113	3
16	<i>Chabertia ovina</i>	—	—	—	4	2	4	4
17	<i>Moniezia benedeni</i>	—	29	—	—	10	29	14
18	<i>Moniezia expansa</i>	—	1	—	—	1	1	1
Total number of parasites		43754	15604	697	745	—	599300	—

The frequency of the occurrence of the parasites in the separate sections of the alimentary tract was as follows:

in 52 animals parasites were found in the small intestine	— 65%
in 42 animals parasites were found in the abomasus	— 52.5%
in 41 animals parasites were found in the caecum	— 51.2%
in 32 animals parasites were found in the large intestine	— 48.7%

Taking in view the species and quantitative set of the examined parasitofauna of cattle we see that the first place is occupied by the following parasites: *Oesophagostomum radiatum*, *Haemonchus contortus*, *Bunostomum phlebotomum*, *Cooperia oncophora* and *Ostertagia ostertagi*.

Among them special attention deserves *Oesophagostomum radiatum*. This species belonged after *Cooperia oncophora* and *Ostertagia ostertagi* to the commonest parasites. I found it in 33 cases what makes 41.2% of the examined animals. The highest numbers of the parasites found were: 124, 139, 191 and 236. Besides this the parasite occurred also in small numbers from 1 — 6 in one host. I found a total number of 1156 parasites. *O. radiatum* is fairly noxious and has a great practical meaning. As known the larvae of this parasite before they settle and reach maturity in the large intestine and caecum they penetrate into the mucous membrane of the small intestine and become encysted. These cysts are visible on the mucous membrane as whitish nodes, and the intestinal wall is swelled and inflamed. In 24 cases I found the presence of parasitic nodes in the small intestine and the examination (histopathological and by the use of a compressor) of some of the nodes revealed the presence of the larvae of *O. radiatum*. The number of such parasitic nodes was in some cases fairly large and amounted from 2 — 7 on the surface of the intestine the size of a hand. The economical role played, among others, by this parasite is evident when the intestines invaded by them show the presence of the parasitic nodes and are therefore classified as inferior in quality or altogether rejected for further use. As known from the data in the literature, *O. radiatum* may under certain circumstances cause serious economical losses. According to Chaltain (1930) some districts in Brasil had to abandon breeding cattle because of the epizootic occurrence of this parasite.

The above mentioned parasite, occupying the second place, *Haemonchus contortus* occurred in 28 cases what makes 35% of

the examined animals. Its intensity was only in three cases fairly high and was expressed in the following numbers: 2961, 1345 and 549. In the remaining cases, however, the intensity was low and fluctuated from 3 to 323 parasites in one host. The total number of the parasites found by me was 6859.

The third mentioned nematode, known as very noxious, *Bunostomum phlebotomum* (in 4 cases ecchymoses on the mucous membrane of the small intestine were found) was less frequent. I found it in 14 (17.5%) animals. The highest invasion amounted to 126 parasites. In the remaining number of animals, in view of the low intensity (from 1 — 47 parasites), this species played no major role.

Ostertagia ostertagi in view of its high intensity could be in certain cases the cause of serious disturbances. The highest invasions numbered: 6626, 5143, 3391, 2593 and 1883 parasites. In the remaining cases the number of parasites was from 1 to 1238 in one host. I found this nematode in 37 cases (46%). As to its extensity it occupied, therefore, the second place.

The most frequently occurring parasite in the examined animals proved to be *Cooperia oncophora*. I found it in 42 animals (52.5%). The highest number of this parasite in one host was 2693. In the remaining cases the intensity was not high and numbered from 1 to 1377 parasites in one host, therefore was of no clinical importance.

On the harmfulness of the two mentioned species of parasites many authors draw attention. Among others Nöller and Schmid (1930) found in grazing cattle chronic diarrhea caused by great numbers of *Ostertagia ostertagi* which in the majority of animals terminated fatally or led to the necessity to direct the animals to slaughter. Also Baker (1937) and Dikmans (1939) observed inflammation of the 4th stomach of calves caused by *Ostertagia ostertagi* and inflammation of the intestines caused by *Cooperia oncophora*. According to Müller (1938) there appeared in heifers at the age of 1/2 to 1 year, remaining on pastures in Bavaria late in summer, a diarrhea, which particularly in wet summers increased in violence. Post-mortem findings revealed the presence of *Ostertagia ostertagi*, *Cooperia oncophora* and *Nematodirus*. The disease lasted several months and the mortality rate reached from 10 to 30%.

The remaining helminths played no practical role in view of the low intensity and extensity of the invasion. I am listing them in a succession of their increasing frequency of occurrence: *Nematodirus filicollis* (1%), *Chabertia ovina* (4%), *Oesophagostomum venulosum* (5%), *Capillaria longipes* (6%), and *Trichostrongylus axei* (12.5%).

According to the data found in the literature *Trichostrongylus axei* is a very frequently occurring parasite in cattle and is regarded by many authors as a pathogenic agent. Andrews, Sippel and Jones (1953) regard this nematode as a common parasite of the south-eastern parts of the U.S.A. and they found that the maximal number of individuals in one adult cow was 400 000. Considerable numbers of this parasite were found also by other authors, e. g. Roberts (1939) found 15 000 — 76 000, and Taylor (1934) — 140 000 specimens, causing the inflammation of abomasus in a heifer. Inflammatory states and diarrhea caused by *T. axei* were described by Stewart et Groften (1941), Gorrie (1943), Plata Guerrero (1931), Andrews et al. (1953). According to Stewart and Croften the animals are invaded on pastures. The disease develops in winter when the animals are not properly fed. Young animals at the age of 1 — 2 years contracted the disease manifested by loss of appetite, diarrhea and emaciation.

Table III

Comparison of extensity of invasion of cattle in Western Poland and Oklahoma (U.S.A.)

Present author		Cooperrider, Pearson, and Kliever, 1948	
Parasite species	% of invaded cattle	Parasite species	% of invaded cattle
<i>Haemonchus contortus</i>	35	<i>Haemonchus contortus</i>	87
<i>Ostertagia ostertagi</i>	46	<i>Ostertagia</i> sp.	95
<i>Trichostrongylus axei</i>	12	<i>Trichostrongylus</i> sp.	79
<i>Cooperia oniophora</i>	54	<i>Cooperia</i> sp.	84
<i>Bunostomum</i>		<i>Bunostomum</i>	
<i>phlebotomum</i>	17	<i>phlebotomum</i>	23
<i>Oesophagostomum</i>		<i>Oesophagostomum</i>	
<i>radiatum</i>	45	<i>radiatum</i>	81
<i>Chabertia ovina</i>	4	<i>Chabertia ovina</i>	28
<i>Trichuris discolor</i>	31	<i>Trichuris ovis</i>	17

The lack in the available literature of data concerning the harmful effect of the separate species of parasites depending on their number makes very difficult to perform a comparative evaluation of the invasions and to estimate their influence on the health of the examined animals. If we take into consideration that the majority of the examined animals were young individuals (up to 2 years), which as a rule exhibit great susceptibility to parasitic invasions, if we consider the species of helminths which are very similar to the parasitofauna of sheep, then with certain

reservations we could accept the scale of harmfulness elaborated by Parnell, Rayski, Dunn et Mackintosh (1954) for the intestinal parasites of sheep and take it as a basis for the orientation as regards the noxiousness of mixed invasions in cattle. As shown by calculations made according to this scale the degree of harmfulness of the invasions in the examined cattle was as regards helminthiasis fairly favourable. In 65% of the animals I found invasions up to 0.5 degree of noxiousness, in 2.5% — 0.70 and 0.85, in 7.5% — from 1 — 2, in 2.5% — 2.5 and 2.75, and only in 1.25% of the examined animals the maximal intensity of the invasion reached 8.5 degree of noxiousness.

In the evaluation of invasion of cattle with nematodes I should draw also attention to the low extensity and intensity of invasion with the separate species of nematodes contrary to the data found in the literature. The results are shown in the Table III and IV.

Table IV
Comparison of intensity of invasion of cattle in Western Poland
and in Southeastern U. S. A.

Parasite species	Present author		Porter, 1942	
	Maxim. intens. of invasion	Extensity	Maxim. intens. of invasion	Extensity
<i>Haemonchus contortus</i>	2961	35	10500	83
<i>Ostertagia ostertagi</i>	6626	46	4000	74
<i>Cooperia oncophora</i>	2683	52	1200	10
<i>Cooperia punctata</i>	1068	20	30000	91
<i>Cooperia pectinata</i>	—	—	28000	32
<i>Trichostrongylus axei</i>	140	12	28000	32
<i>Trichostrongylus colubriformis</i>	—	—	9700	9
<i>Nematodirus helvetianus</i>	1433	35	3000	15
<i>Bunostomum phlebotomum</i>	126	17	1374	62
<i>Oesophagostomum radiatum</i>	236	41	6256	59
<i>Trichuris discolor</i>	33	29	372	17.6
<i>Capillaria longipes</i>	8	6	400	7.4

The comparison of the results of extensity of invasion of three groups of cattle (table III and IV) shows that the animals examined by me showed almost two times lower extensity. In this respect exceptional are *Cooperia oncophora*, *Nematodirus helvetianus* and *Trichuris discolor* which showed a relatively high percentage of invasion. This percentage was for *C. oncophora* 5 times higher, for *N. helvetianus* and *T. discolor* almost twice higher.

As regards the intensity of invasion the animals examined by me were also in a favourable position. As shown in Table IV the maximal numbers of the separate species of parasites were, according to my data, 2 — 200 times lower from that given by Porter. The difference concerns *Ostertagia ostertagi* and *Cooperia oncophora* which were found by me in numbers almost twice higher.

Comparing the set of the helminthofauna of animals examined by me with the set of the parasitofauna of cattle in other countries it should be stated that the number of species of the nematodes in cattle in Poland is not high. I found 16 species, Rasovskaja (1924) — 10, Sjöberg (1926) — 16, Cooperrider (1952) — 15, Porter (1942) — 12 species and other American authors, as Baker (1947—1948), Koutz (1949), Cooperrider, Pearson et Kliever (1948), Threlkeld et Bell (1946), Bailey et Herlich (1953), Bailey et Thorson (1954), Vegors, Sell, Baird et Stewart (1955), Dikmans et Kates (1955) found 11 species of the most commonly occurring parasites. A greater number of species (25) is reported by Dikmans (1945). As regards the species set, the helminthofauna of cattle in Poland is richer than the parasitofauna in Turkistan, almost the same as in Germany, and considerably poorer than in the United States. The majority of the species found by me are cosmopolitan and the rest have a wide geographical distribution.

The material examined by me draws attention by the complete absence of *Gongylonema pulchrum* and *Trichostrongylus colubrifomis*. Studies conducted by Kwiatkowska et Mościcki (1938) indicate that *G. pulchrum* occurs fairly frequently in cattle. The cited authors examined in 1934 — 1938 a total number of 529 cows from the districts Pomorze, Warszawa, Białystok, Polesie and Wołyń. *Gongylonema pulchrum* was found in 121 cases what makes 22.8% of the examined material, whereby the percentage of invasion of animals in the separate districts differed insignificantly. The number of parasites found in one host ranged from 1 to 10.

No pathogenic effect of the parasite was noticed. In my examinations of the oesophagus of cattle I never found *Gongylonema*. It seems to me that this nematode belongs to very rare parasites of cattle in Western Poland. Final conclusions can be reached when my studies will be extended to a greater number of dissections of cattle and sheep conducted on animals from various districts in Western Poland. Then also suitable conclusions can be drawn as regards extensity and intensity of the occurrence of this parasite.

A review of the data in the literature shows that our informations concerning the occurrence of *Trichostrongylus colubriformis* in cattle are scanty and deal not with its pathogenic role. In my opinion further studies on the helminthofauna of cattle in Poland should, in view of the common occurrence of *T. colubriformis* in sheep and goats, prove its presence.

The tapeworms (*Moniezia benedeni* and *M. expansa*) did not show in examined animals high extensity (15%) neither intensity (1 — 10 individuals). Therefore it should be concluded that, as regards the invasion with tapeworms, the examined cattle presented a favourable material.

As indicated by data in the available literature the tapeworms may cause serious losses in breeding cattle, particularly among young animals. Link, Norman, Levin, Danks et Woelfler (1950) describe numerous cases of moniesosis among heifers. Out of the total number of 79 heifers 19 animals succumbed to the disease most likely caused by tapeworms. Post-mortem examination of a heifer, age 3 months, revealed 32 individuals of *M. expansa*. In 42 animals the pathological symptoms were manifested by exhaustion, inhibition of growth and lower vitality.

In the final evaluation of helminthiasis of the alimentary tract in the examined material attention should be turned also to the rare occurrence (3 times) of the trematode *Paramphistomum cervi* which in view of its low intensity played no clinical role.

It is generally accepted that adult trematodes cause no pathological symptoms. However, Zadura and Nieć (1952) described a case marked by high invasion with *P. cervi* in a cow which terminated fatally to the animal. The enormous number (about several thousands) of parasites fixed one beside the other to the mucous membrane of the rumen and reticulum caused atony of the stomach and disturbances in the digestion processes.

Comparing the set of nematodes fauna of cattle with the set of helminths of sheep and goats (Table V) there can be seen dif-

Table V
Comparison of nematodes of cattle, sheep and goat in Western Poland

No.	Parasite species	Cattle		Sheep		Goat	
		% of invaded animals	total number of parasites	% of invaded animals	total number of parasites	% of invaded animals	total number of parasites
1	<i>S. papillosus</i>	—	—	40	759	9	205
2	<i>H. contortus</i>	35	6859	66	4691	79	12773
3	<i>O. ostertagi</i>	46	32674	10	11	2	3
4	<i>O. circumcincta</i>	—	—	72	8106	69	18569
5	<i>O. trifurcata</i>	—	—	50	1462	27	2048
6	<i>O. lyrata</i>	30	1284	—	—	—	—
7	<i>T. axei</i>	12	489	54	42999	34	18953
8	<i>T. colubriformis</i>	—	—	66	55161	55	101000
9	<i>T. vitrinus</i>	—	—	18	455	9	3521
10	<i>T. capricola</i>	—	—	4	2	10	2176
11	<i>N. filicollis</i>	1	16	26	946	14	139
12	<i>N. spathiger</i>	—	—	12	466	7	69
13	<i>N. helvetianus</i>	35	2811	12	147	—	—
14	<i>C. oncophora</i>	52	12091	32	548	2	1
15	<i>C. mcmasteri</i>	36	443	16	433	—	—
16	<i>C. curticei</i>	—	—	6	6	—	—
17	<i>C. punctata</i>	20	1484	—	—	—	—
18	<i>B. trigonocephalum</i>	—	—	16	169	2	6
19	<i>B. phlebotomum</i>	17	256	—	—	—	—
20	<i>Ch. ovina</i>	4	4	30	89	55	621
21	<i>O. venulosum</i>	5	113	48	1386	72	2905
22	<i>O. radiatum</i>	41	1156	—	—	—	—
23	<i>T. ovis</i>	4	9	54	190	44	139
24	<i>T. skrjabini</i>	—	—	4	5	—	—
25	<i>T. discolor</i>	29	162	—	—	—	—
26	<i>C. longipes</i>	6	19	16	53	9	18
27	<i>S. ovis</i>	—	—	4	5	10	133

ferences concerning both the number of species and the species set of the parasitofauna, as well as the percentage of the invaded hosts and the total number of the separate species of parasites found in animals. The comparison of the sets of parasites of intestines shows that the composition of the parasitofauna in cattle was as regards the number of species poorer than in the sheep

and goat. I found in cattle 16 species, in goats — 18 and in sheep — 22. In domestic ruminants I diagnosed the total number of 28 species of nematodes. These nematodes can be subdivided depending on the host species into three groups. To the first group can be included parasites specific to cattle, to the second — parasites which invade all our ruminants, to the third — worms specific to sheep and goats. To the parasites specific to cattle should be included: *Ostertagia lyrata*, *Cooperia punctata*, *Bunostomum phlebotomum*, *Oesophagostomum radiatum* and *Trichuris discolor*. To the parasites found in all our ruminants should be included: *Haemonchus contortus*, *Ostertagia ostertagi*, *Cooperia oncophora*, *C. mcmasteri*, *Trichostrongylus axei*, *Nematodirus helvetianus* and *Capillaria longipes*. *O. ostertagi* and *C. mcmasteri* occurred more frequently and in higher numbers in cattle than in sheep and goats. To the parasites specific to sheep and goats belong: *Strongyloides papillosus*, *Ostertagia circumcincta*, *O. trifurcata*, *Trichostrongylus colubriformis*, *T. vitrinus*, *T. capricola*, *Nematodirus filicollis*, *N. spathiger*, *Cooperia curticei*, *Bunostomum trigonocephalum*, *Trichuris skrjabini*, *Skrjabinema ovis*, *Chabertia ovina*, *Oesophagostomum venulosum* and *Trichuris ovis*. The three last mentioned species and *N. filicollis* occurred sporadically and in small numbers also in cattle.

On the specificity of parasites and resistance of hosts attention was drawn among others also by Porter (1953). According to his data the heifers grazing on pastures strongly contaminated by cattle showed higher intensity of invasion with *Haemonchus* than lambs remaining on the same terrains. Also *Cooperia punctata* occurred in heifers in numbers several times higher than in lambs but the intensity of *Cooperia curticei* in sheep was higher than in cattle. However, such parasites of cattle as *Oesophagostomum radiatum*, *Nematodirus helvetianus* and *Ostertagia ostertagi* were not recorded in small ruminants. The cited author examined also the lambs which grazed together with heifers on pastures previously attended by adult sheep and found that they were invaded with a greater number of *Haemonchus*, in comparison with cattle. Heifers proved to be resistant to the invasion of *Bunostomum trigonocephalum*, *Oesophagostomum columbianum*, *Strongyloides papillosus* and *Trichostrongylus colubriformis*. As regards tapeworms *Moniezia expansa* was found in the two hosts, but *Moniezia benedeni* only in heifers.

As regards the total number of parasites and the percentage of hosts invaded with the separate species the small ruminants were superior to cattle. In small ruminants I found great numbers of parasites of the following species: *Trichostrongylus colubriformis* — 55 161 and 101 000 (sheep and goat), *Trichostrongylus axei* — 42 999 and 18 953 (sheep and goat), *Trichostrongylus vitrinus* — 3591 (goat) and *Oesophagostomum venulosum* — 2905 (goat), whereby the highest percentage of invasion of hosts for 10 species most commonly occurring remained within the limits 32 — 79. In cattle I noticed only higher numbers of parasites as regards *Ostertagia ostertagi* (32 674), *Cooperia oncophora* (12 691) and *Haemonchus contortus* (6859), and the highest percentages of the invaded hosts for 6 species fluctuated from 35 — 52.5.

Summing up the results of the present work it can be concluded that:

(1) the species set of helminths included 1 species of trematode, 2 species of tapeworms and 16 species of nematodes;

(2) *Haemonchus* from cattle is supposedly a separate species;

(3) as regards extensity the examined animals showed a high percentage of invasion, expressed by the number 78.7;

(4) the intensity of invasion of the separate species of parasites with exception of *Ostertagia ostertagi*, *Cooperia oncophora* and *Haemonchus contortus* was not high;

(5) serious economical role could play the invasions of the three listed species and *Oesophagostomum radiatum*.

Author's address:
Katedra Parazytologii W. S. R.
Wrocław, Norwida 27

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STRESZCZENIE

Praca powyższa stanowi drugą fazę badań nad parazytofauną domowych przeżuwaczy. Badania sekcyjne przewodu pokarmowego bydła przeprowadzano w latach 1949 — 1956. Ogólna liczba zbadanych przewodów pokarmowych wynosiła 80. Ponadto przeprowadzono badania sekcyjne 300 przelyków bydła. Materiał do badań pobierano od zdrowych zwierząt, przeważnie młodych, poddawanych ubojowi w rzeźni.

Skład parazytofauny obejmował *Trematoda* (10% badanego bydła), *Cestoda* (15%) i *Nematoda* (75%). Z przywr stwierdzono *Paramphistomum cervi*, z tasiemców — *Moniezia expansa* (1%), *Moniezia benedeni* (14%), a z nicieni: *Ostertagia ostertagi* (46%), *O. lyrata* (30%), *Trichostrongylus axei* (12%), *Haemonchus contortus* (35%), *Cooperia oncophora* (52%), *C. mcmasteri* (36%), *C. punctata* (20%), *Nematodirus helvetianus* (35%), *N. filicollis* (1%), *Bunostomum phlebotomum* (17%), *Oesophagostomum radiatum* (41%), *O. venulosum* (5%), *Chabertia ovina* (4%). *Capillaria longipes* (6%), *Trichuris discolor* (29%) i *T. ovis* (4%). Gatunki *O. lyrata*, *C. punctata*, *B. phlebotomum*, *O. radiatum* i *T. discolor* nie były rejestrowane dotychczas w Polsce.

Pod względem ekstensywności badane pogłowie wykazywało 78,7% zarażenia. Intensywność inwazji poszczególnych gatunków nicieni, z wyjątkiem *Ostertagia ostertagi* (6626), *Cooperia oncophora* (2683) i *Haemonchus contortus* (2961), była niewielka i wynosiła dla *Oesophagostomum radiatum* 236, *Bunostomum phlebotomum* 126, a dla pozostałych pasożytów 2 — 1433 osobników.

Ogólna ilość znalezionych pasożytów wynosiła 60 197, z czego na przywry przypada 267, na tasiemce — 30 i na nicienie — 59 900.

Zastosowanie 0,75 — 1% ługu sodowego do wyosobnienia szczecinek płciowych umożliwiło stwierdzenie nowych szczegółów dotyczących budowy gubernaculum *Oesophagostomum radiatum* i *Oe. venulosum*.

